Direct Releases in the CRA PA

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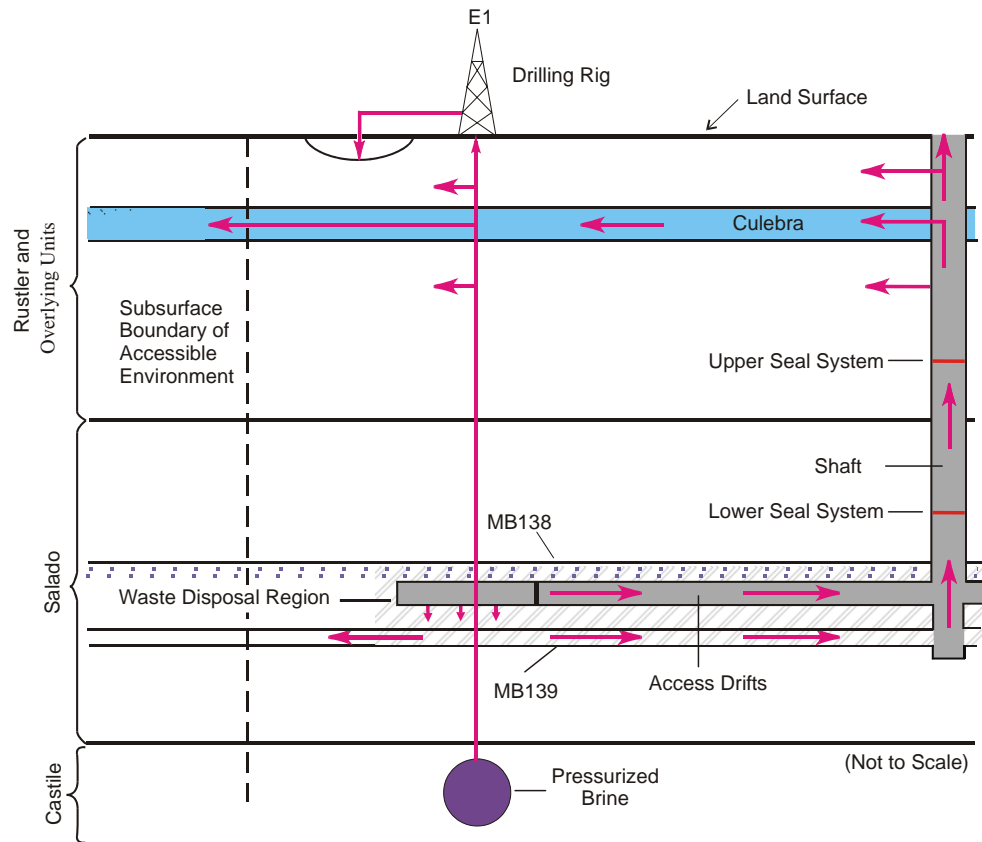# Direct Release Models

Direct Releases occur at the time of an intrusion

- **Cuttings**: solid material removed by drill bit
- **Cavings**: solid material removed by circulation of drilling fluid
- **Spallings**: solid material released because of gas flow towards borehole
- **Direct Brine Releases**: radionuclides released to the surface in brine flowing from borehole

Conceptual Model for Cuttings and Cavings

"This model is <u>fundamentally appropriate</u>. … It appears to be capable of accurately representing the waste that might be removed during a drilling intrusion and is fully adequate for implementation in support of the WIPP performance assessment." (CCA Sec. 9.3.1.1)
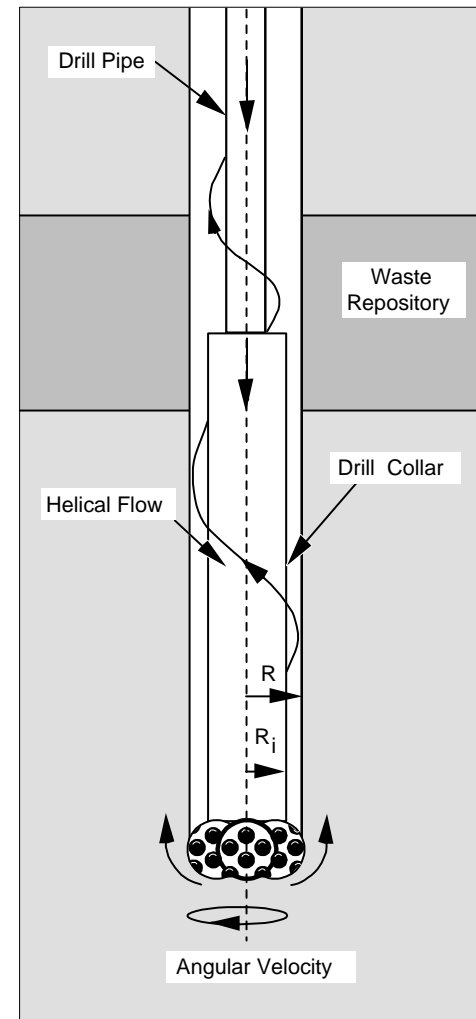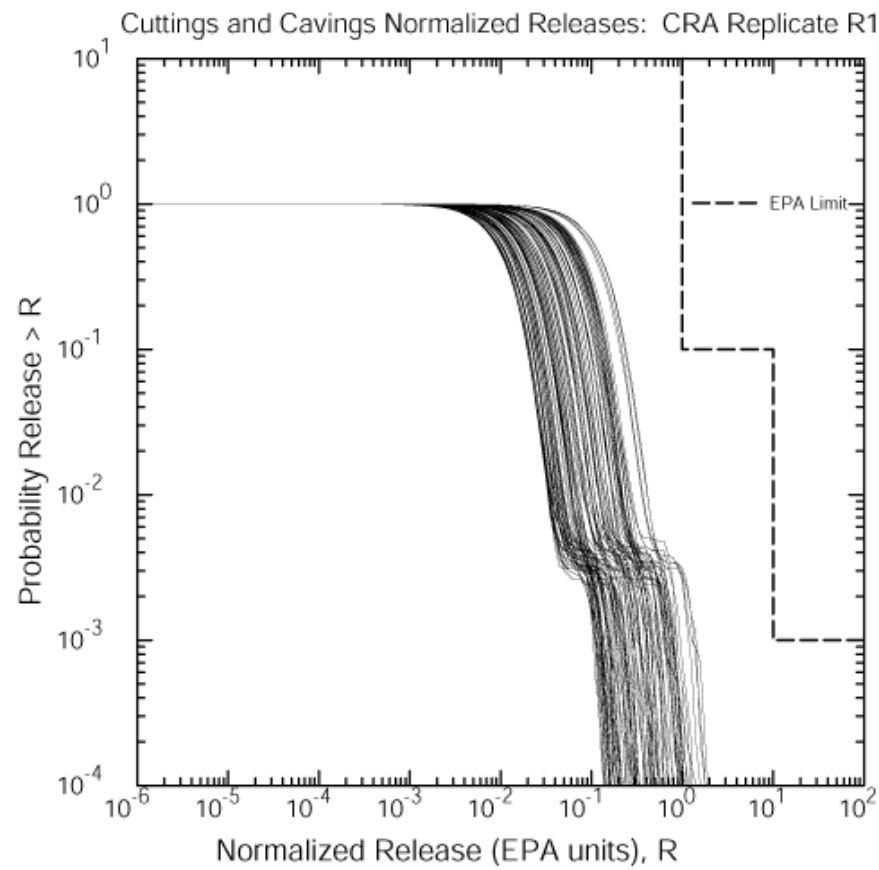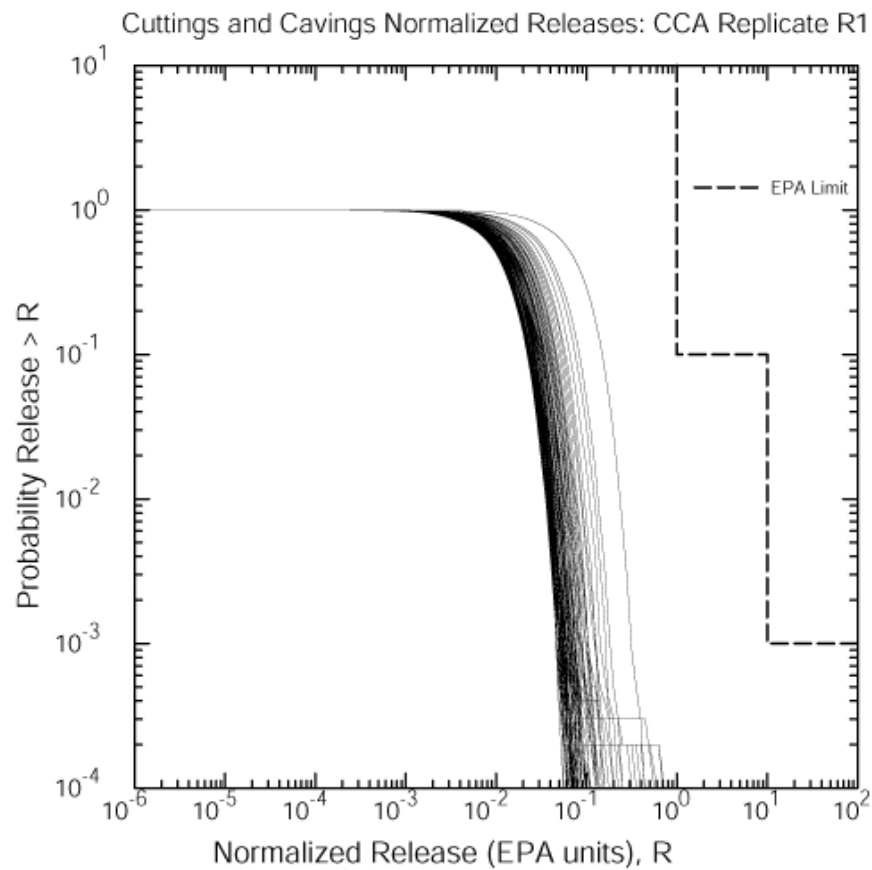
Changes affecting Cuttings and Cavings

- **Waste shear strength**
  - **CCA: sampled from uniform distribution (0.05 to 10 Pa)**
  - **CRA: sampled from loguniform distribution (0.05 to 77 Pa) as in 1997 PAVT (V-B-14 Sec. 4.2)**
- **Drill string angular velocity**
  - **CCA: constant at 7.8 rad/sec (median of distribution)**
  - **CRA: sampled from cumulative distribution (4.2 to 23 rad/sec) as in 1997 PAVT (V-B-14 Sec. 5.1)**
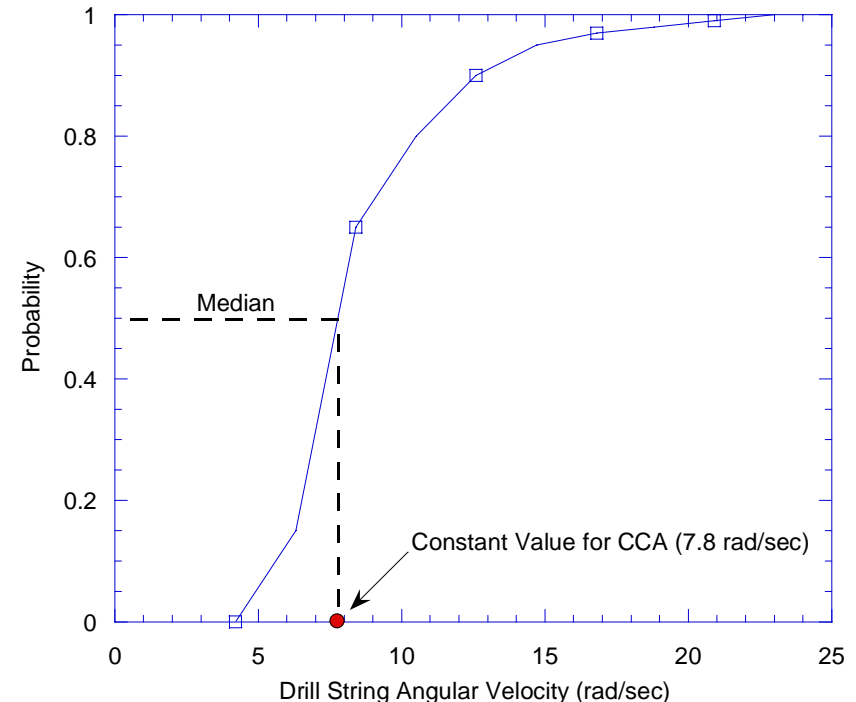
- **Drilling rate updated (from 46.8 to 52.5 bh/km^2/10K yr)**
- **Inventory changes affect releases by cuttings and cavings**

Comparison of Cuttings and Cavings Releases

Conclusions: Cuttings and Cavings

- **Larger releases due to increase in drilling rate**
- **Greater uncertainty due to changes in waste shear strength and drill string angular velocity**
- **Altered shape of CCDFs due to changes in inventory**
  - **Greater detail included for some waste streams**
  - **Small-volume, high-activity waste streams responsible for "knee" in CCDF**

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Historical Perspective on Spallings

- **The Conceptual Model Peer Review (CMPR) found that the original spall model developed prior to the CCA was <u>inadequate</u>. (II-G-21 Sec 3.1). DOE developed a new mechanistic model for spallings (Hansen et al., 1997; IV-A-6)**

- **The CMPR found that this new model was <u>adequate</u> to demonstrate that the values for potential <u>spall volumes</u> included in the CCA calculations were <u>reasonable</u>. (II-G-22 Sec 3.1) However, the CCA spall model remained inadequate. (II-G-22 Sec 4)**

- **PAVT implemented a simple representation of spall volumes.**

- **The DOE committed to develop a new spall model prior to recertification.**

- **New spall model has been developed based on mechanistic model**
  - **Peer review in July 2003**
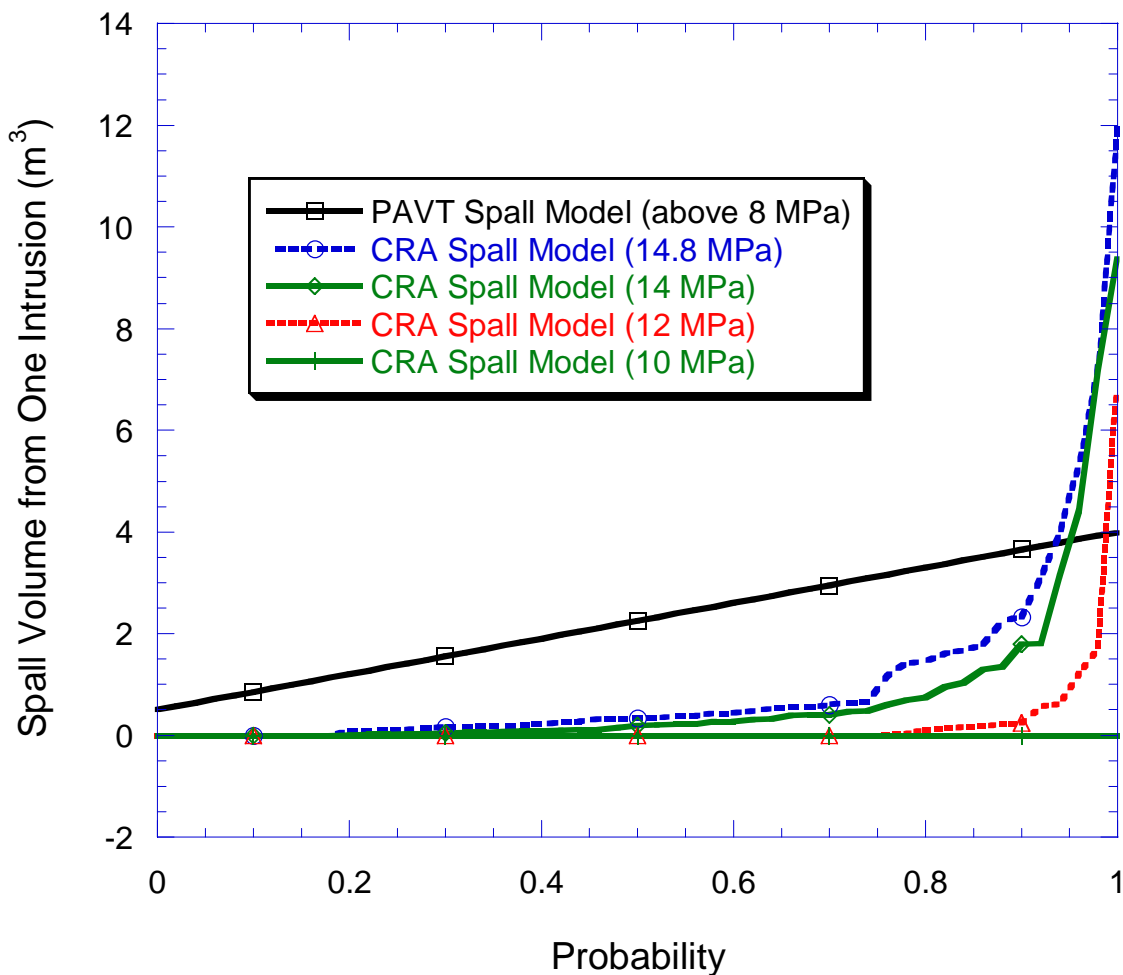 - **Implemented in DRSPALL code**

Conceptual Model for Spallings
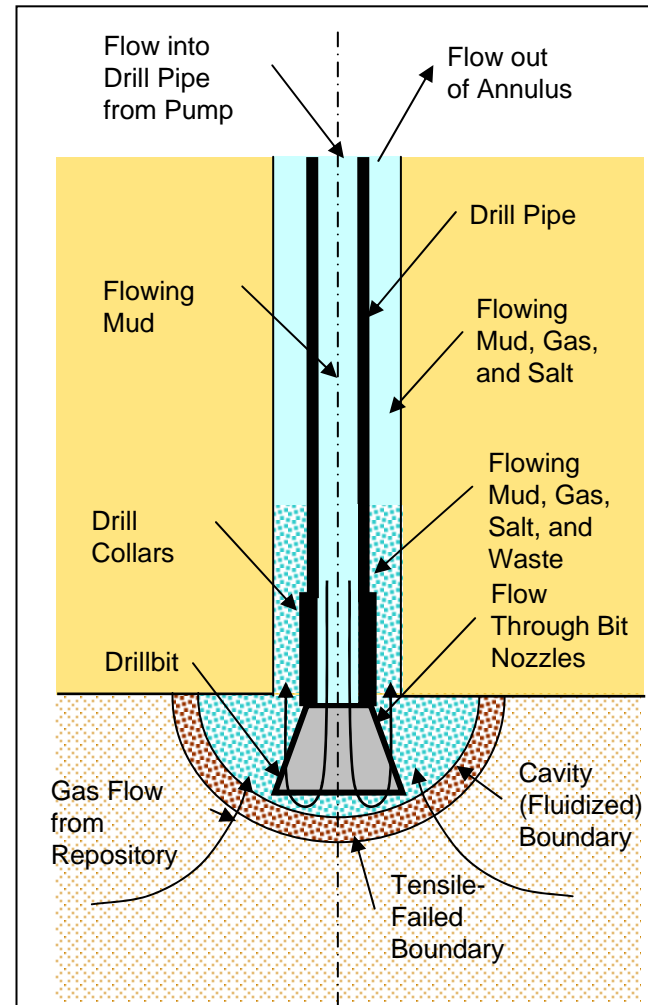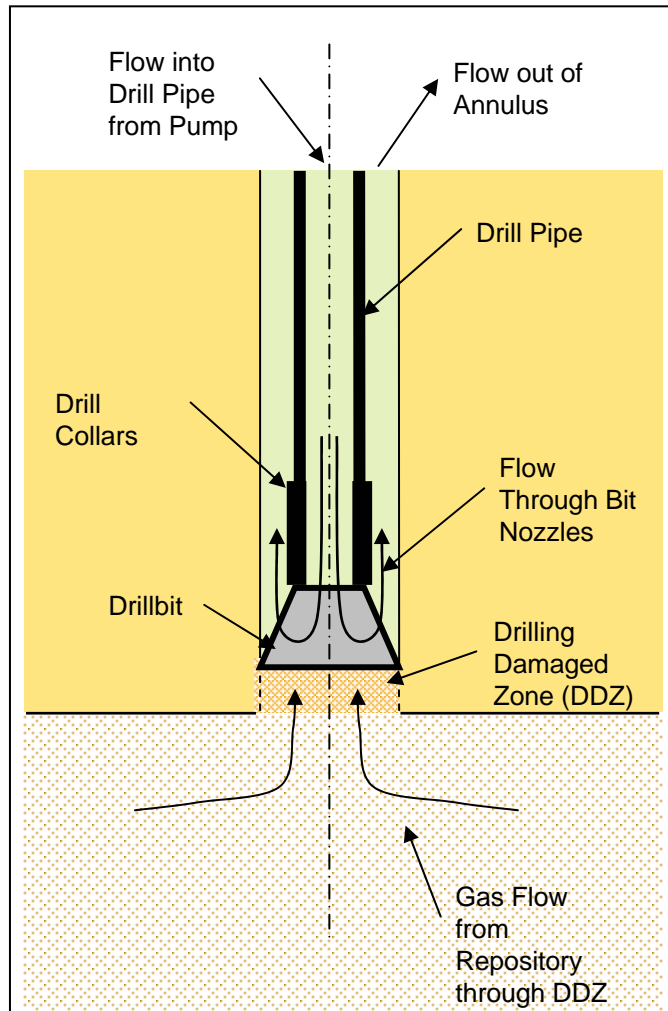
Peer Review Results

- **Spallings Peer Review conducted 7 – 10 July 2003**
- **Peer review (Yew et al., Oct 2003) determined**
  - **"The new spallings conceptual model appears generally sound in its structure and reasonableness"**
  - **"The proposed implementation of the new spallings model appears reasonable"**
  - **"Output from sensitivity analyses indicates acceptable results"**

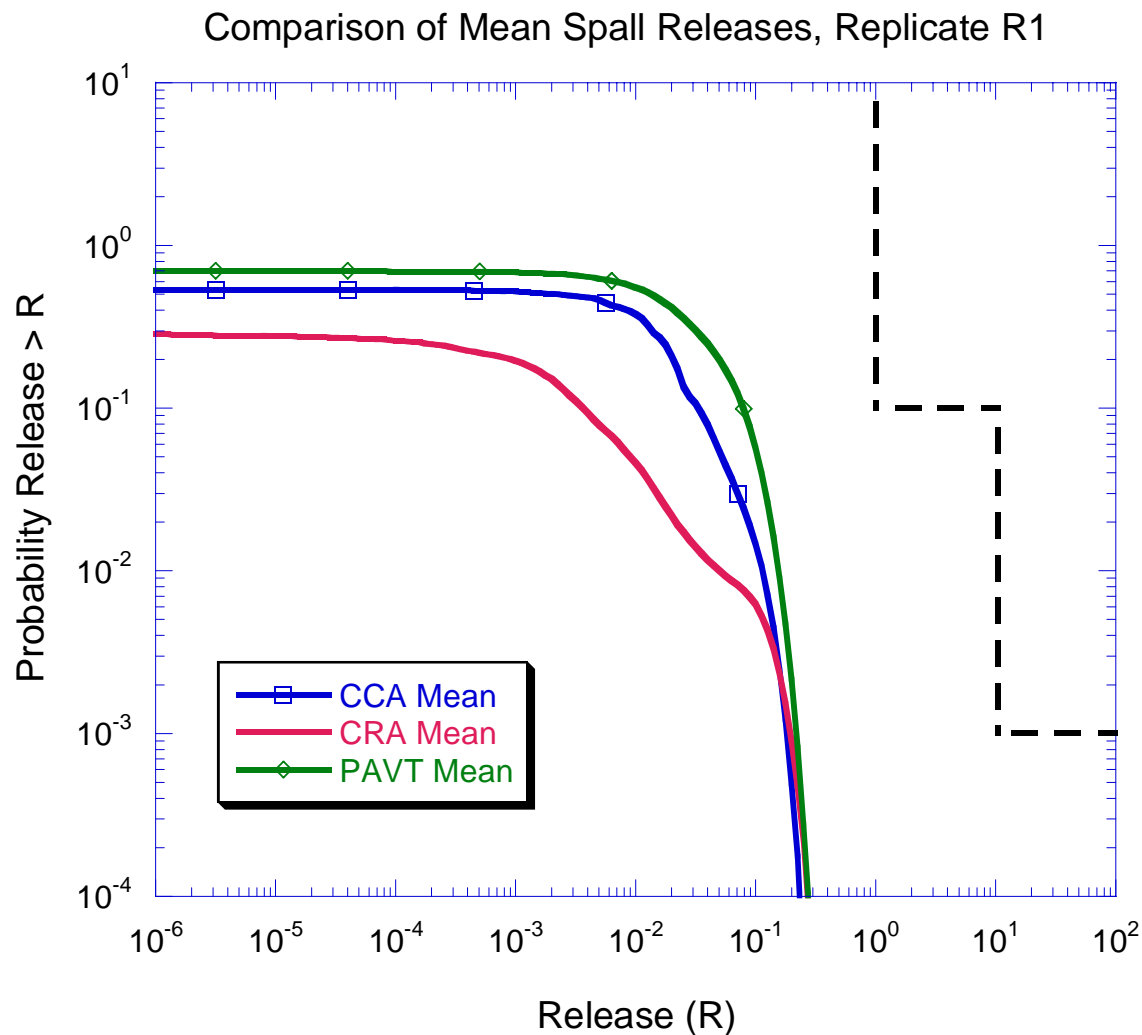# Comparison of Spall Volume from One Intrusion

Comparison of Spall Releases

Spallings Normalized Releases: CCA Replicate R1

Spallings Normalized Releases: CRA Replicate R1
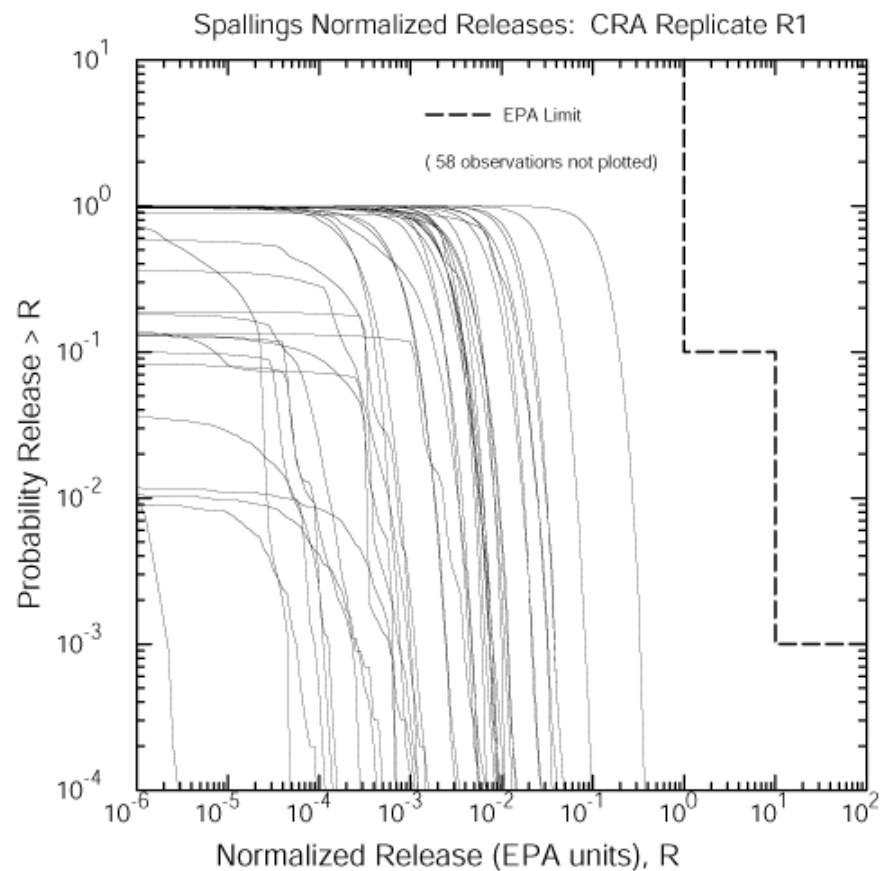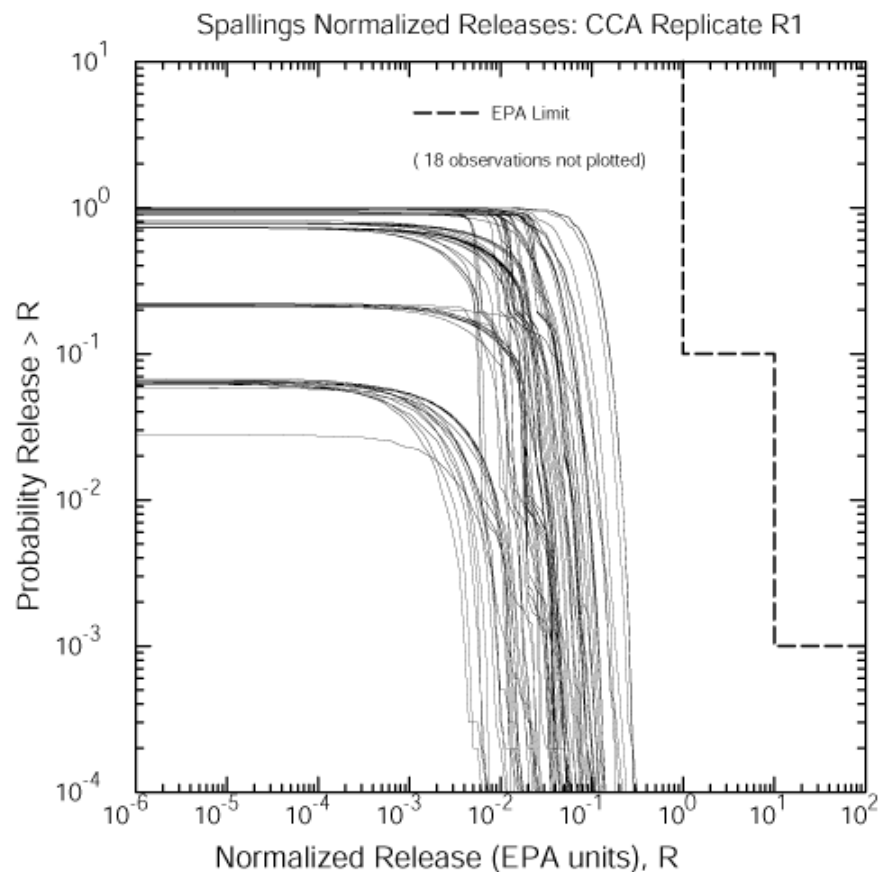
Comparison of Spall Releases (cont)
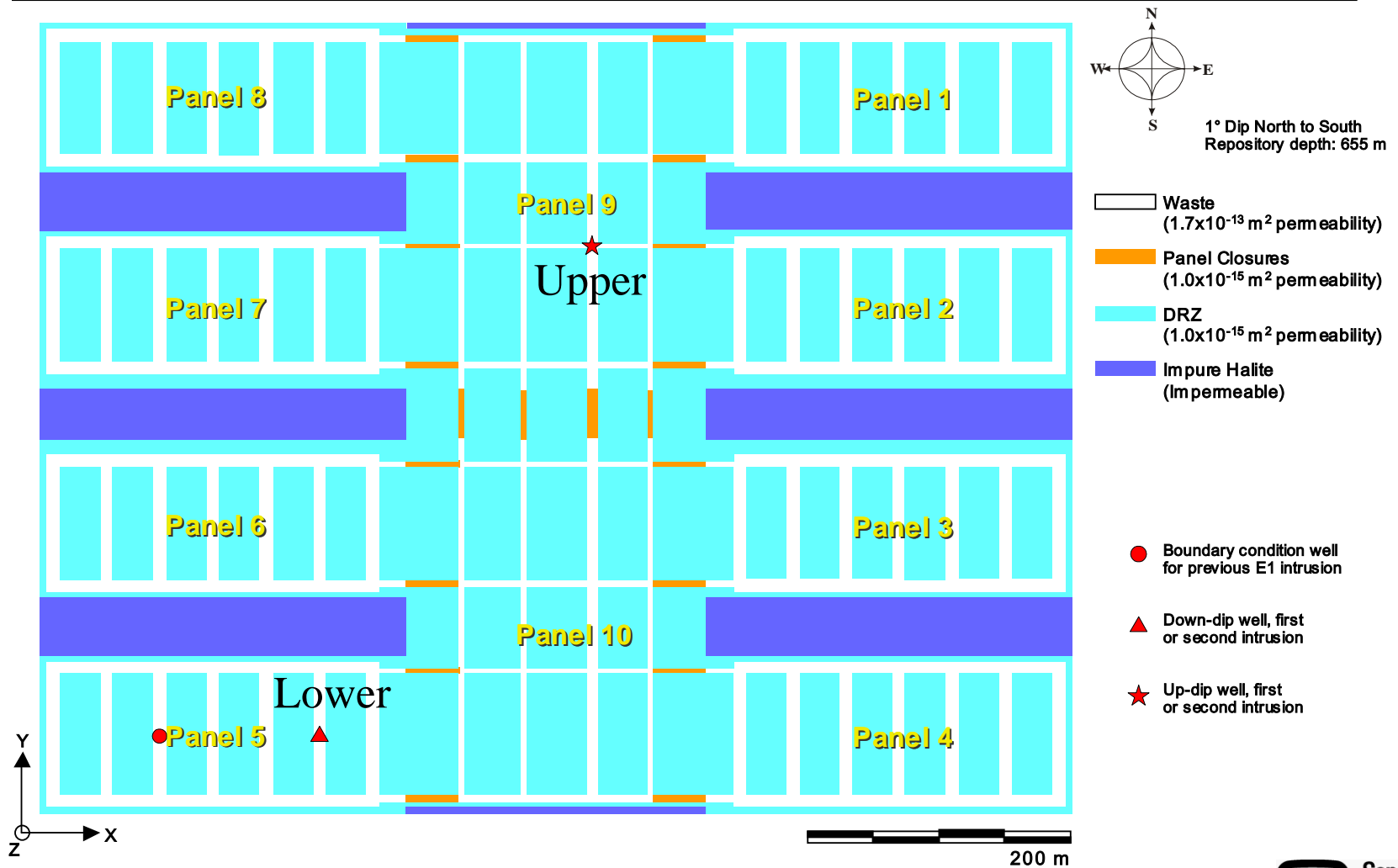

Comparison of Mean Spall Releases, Replicate R1
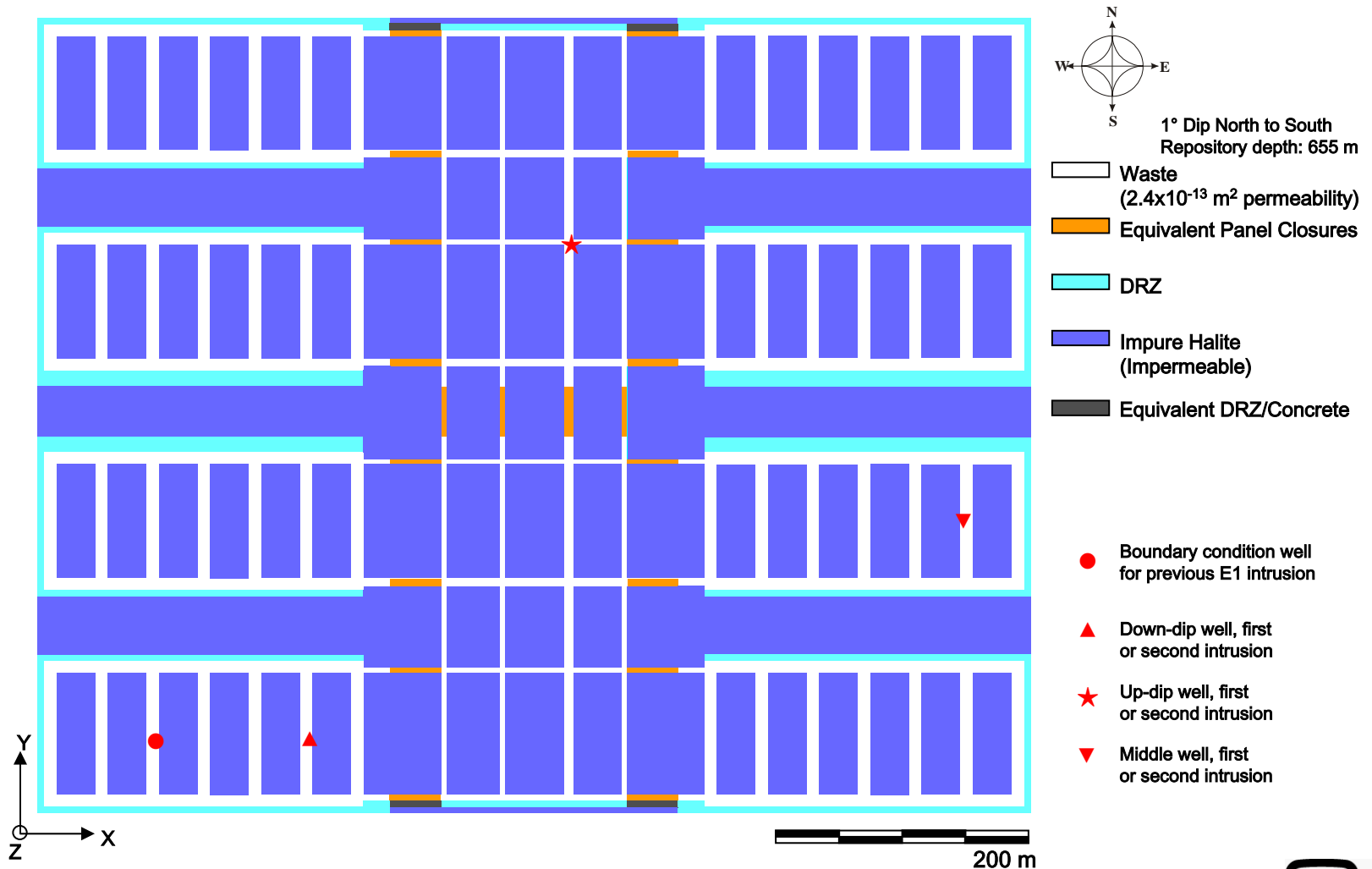
Conceptual Model for Direct Brine Releases

- **CMPR concerns with DBR model resolved during post-CCA review (II-G-22 Section 4.0)**
- **Conceptual model unchanged since CCA**
  - **Parameters changed to account for panel closures**
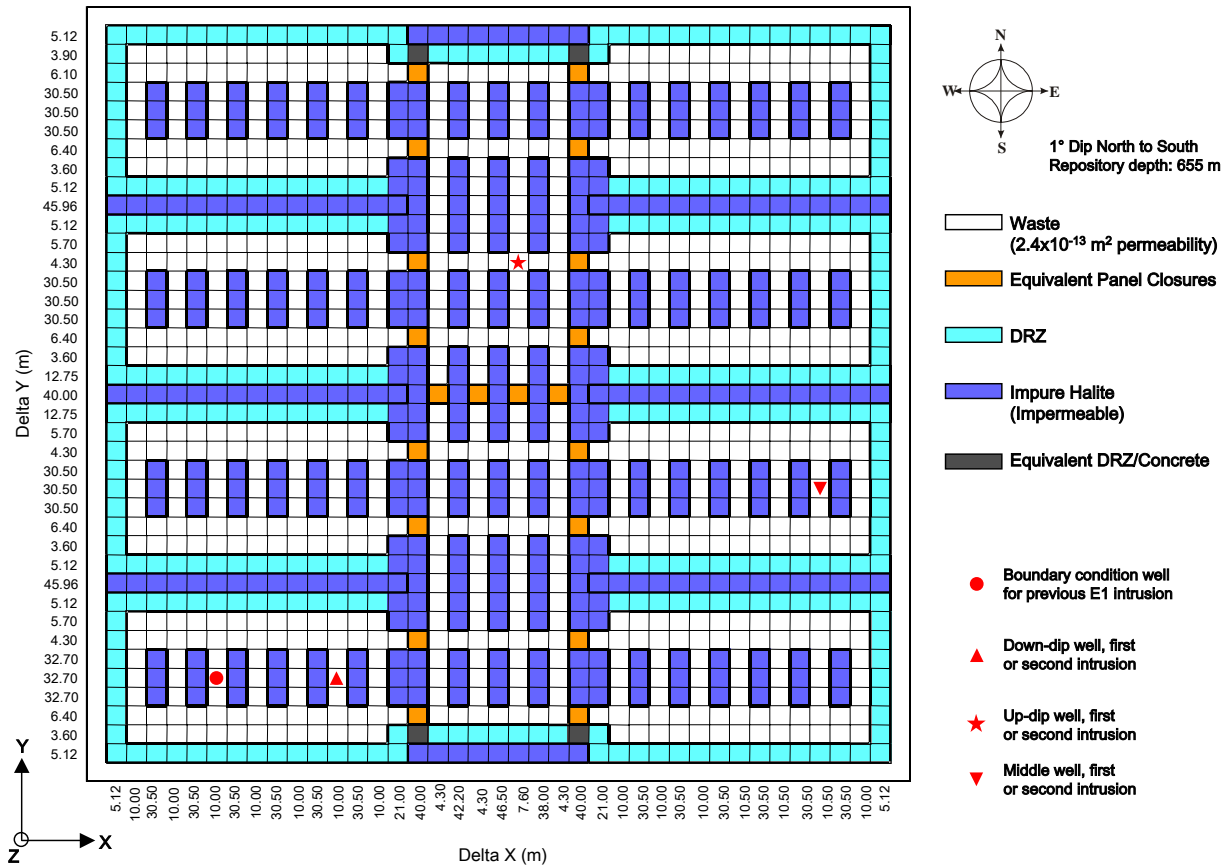 - **Additional set of "middle" intrusion scenarios (panel closures)**

DBR Material Map (CCA)

DBR Material Map (CRA)

N
W — E
S

1° Dip North to South
Repository depth: 655 m

☐ Waste
(2.4x10⁻¹³ m² permeability)

◼ Equivalent Panel Closures

◼ DRZ

◼ Impure Halite
(Impermeable)

◼ Equivalent DRZ/Concrete

● Boundary condition well
for previous E1 intrusion

▲ Down-dip well, first
or second intrusion

★ Up-dip well, first
or second intrusion

▼ Middle well, first
or second intrusion

Y
Z X

200 m

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Logical DBR Grid (CRA)

Note: Model cells are not to scale. The actual dimensions of the grid blocks are indicated along the edge of the diagram.

Relation to BRAGFLO Grid (CRA)

Legend:
- ● Boundary condition well for previous E1 intrusion
- ▲ Down-dip well, first or second intrusion
- ★ Up-dip well, first or second intrusion
- ▼ Middle well, first or second intrusion

Region 1

Region 2

Region 3

Pore volume averaged pressure and saturation from each region transferred to similar region in BRAGFLO DBR grid

Region 3 — Single Panel | SEAL | Region 2 — SRR | SEAL | Region 1 — NRR

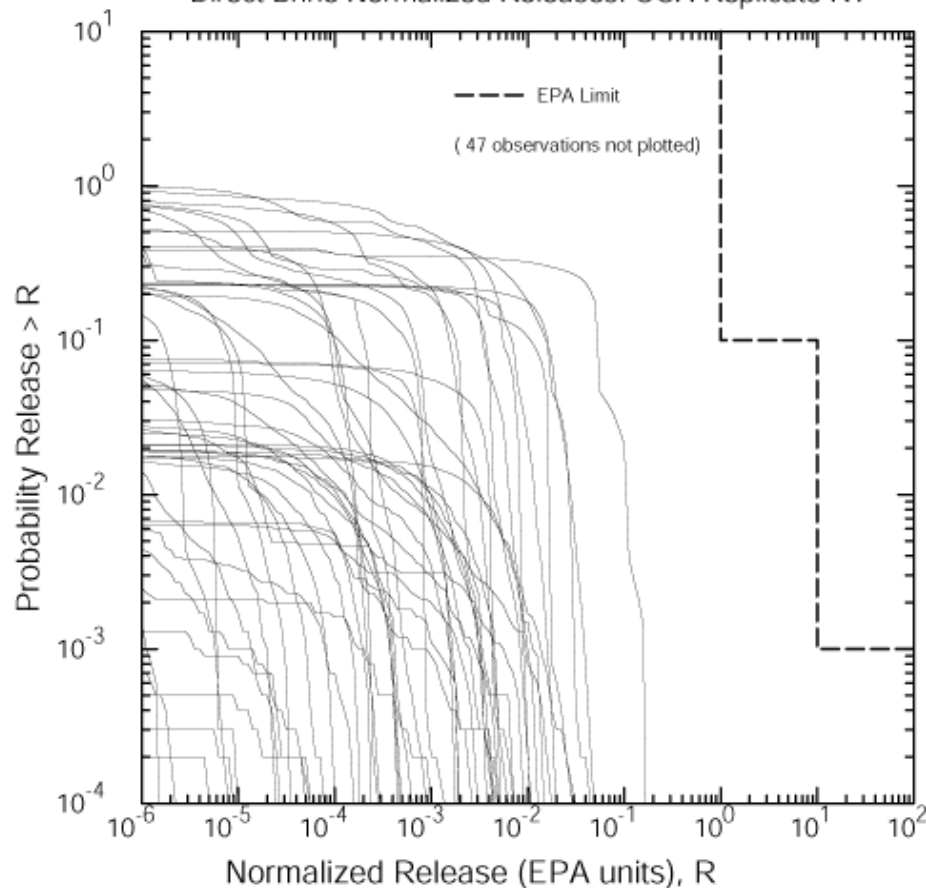Refined BRAGFLO DBR grid geometry

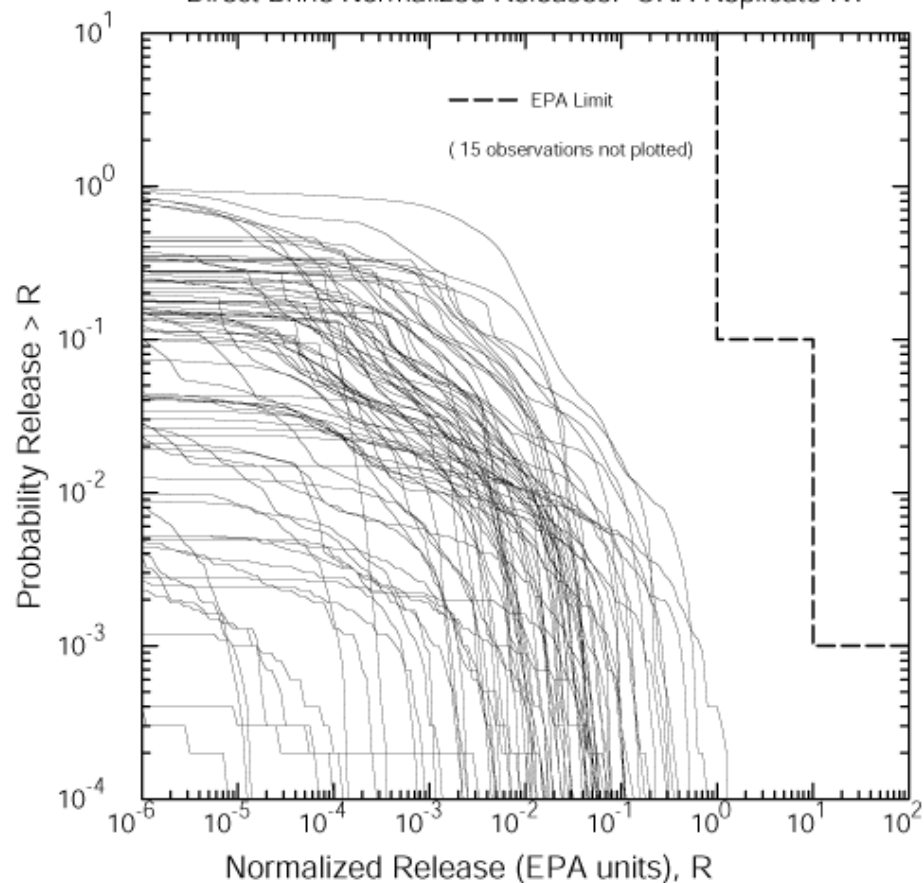Representation of waste area in BRAGFLO grid (not to scale)
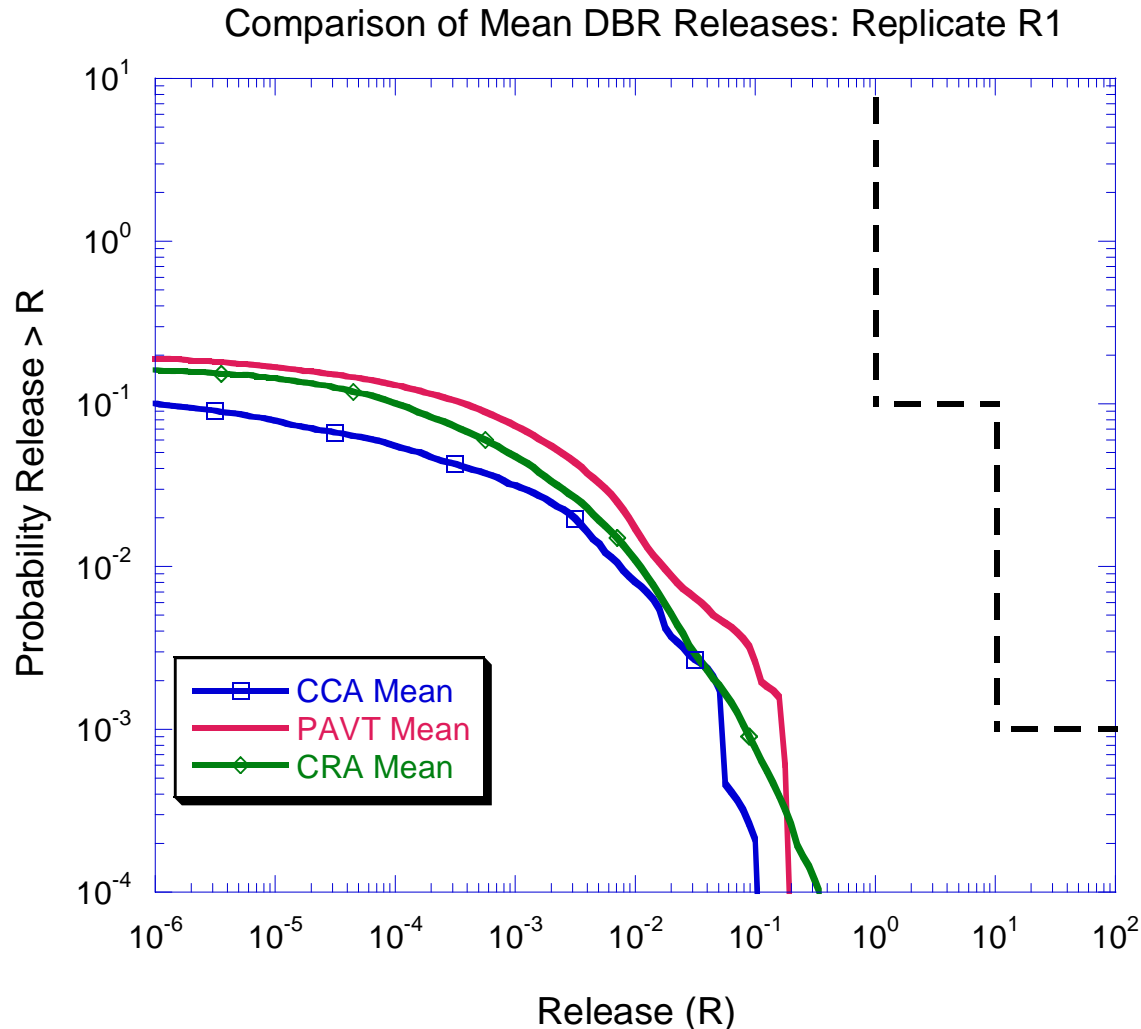
Comparison of Direct Brine Releases

Direct Brine Normalized Releases: CCA Replicate R1

Direct Brine Normalized Releases: CRA Replicate R1
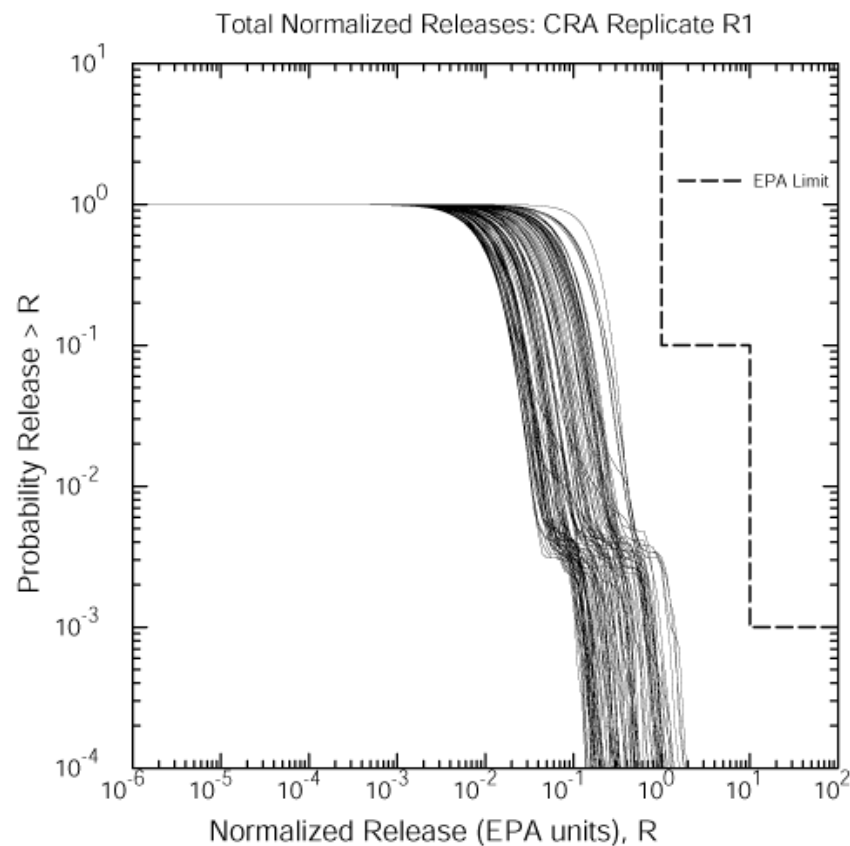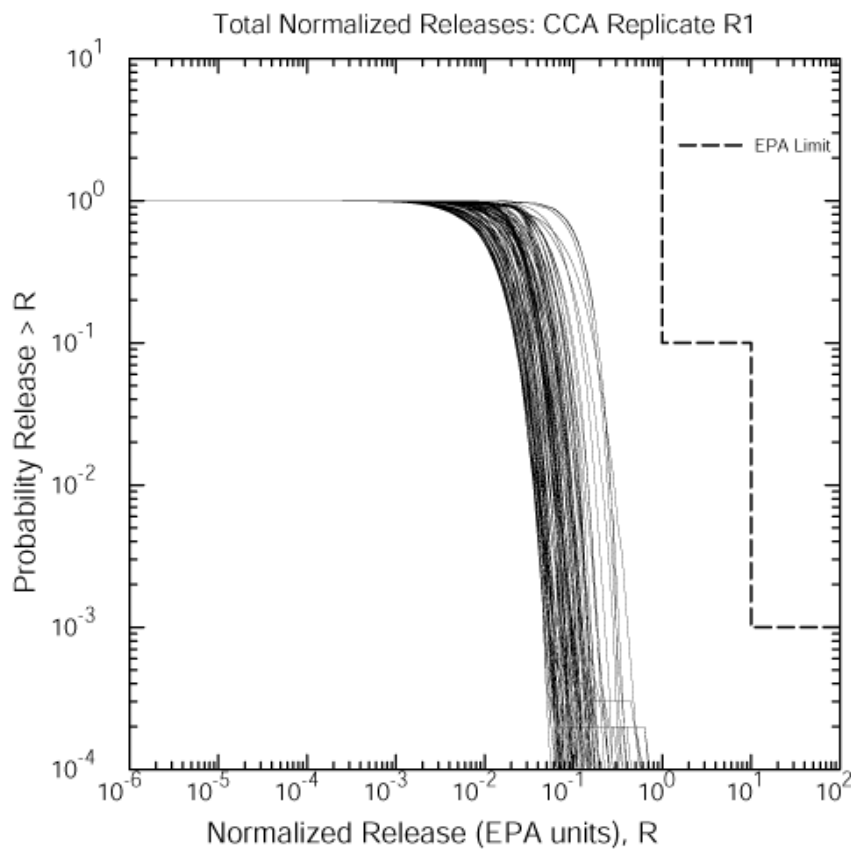
Comparison of Direct Brine Releases (cont)

Comparison of Mean DBR Releases: Replicate R1
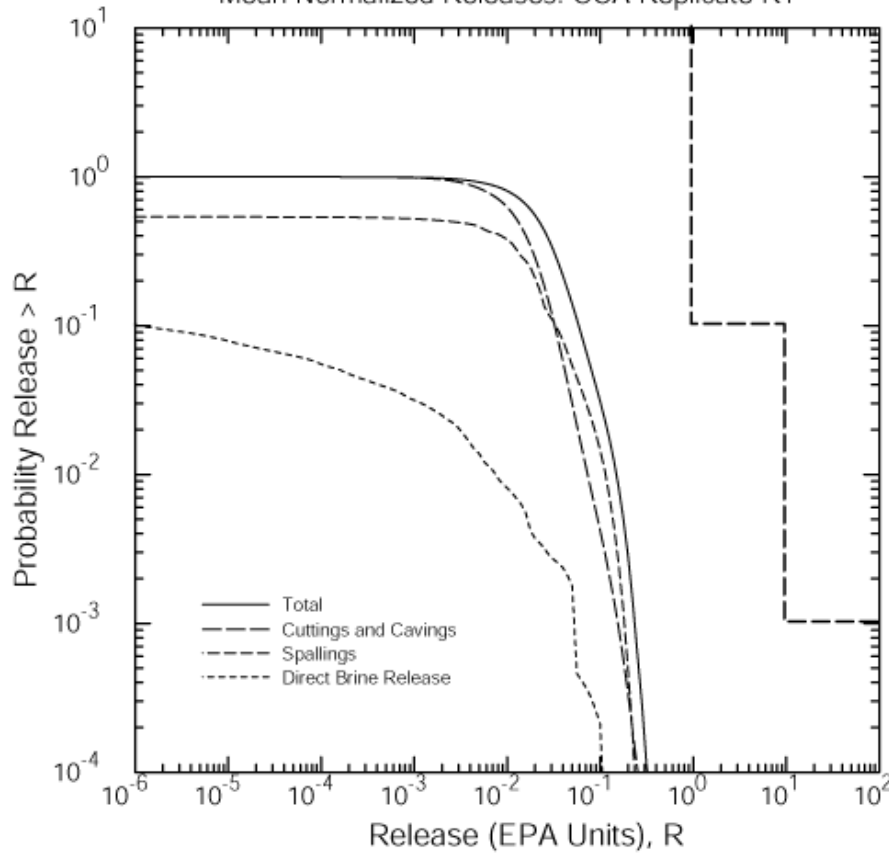
Construction of CCDFs

- **CCDFGF code re-written for CRA to improve**
  - **Parameter and data traceability**
  - **Accommodate changes for panel closures (middle intrusion cases)**
  - **Future code maintenance**
- **Algorithms for computing releases are similar to CCA**
  - **For each parameter vector, generate 10,000 random futures**
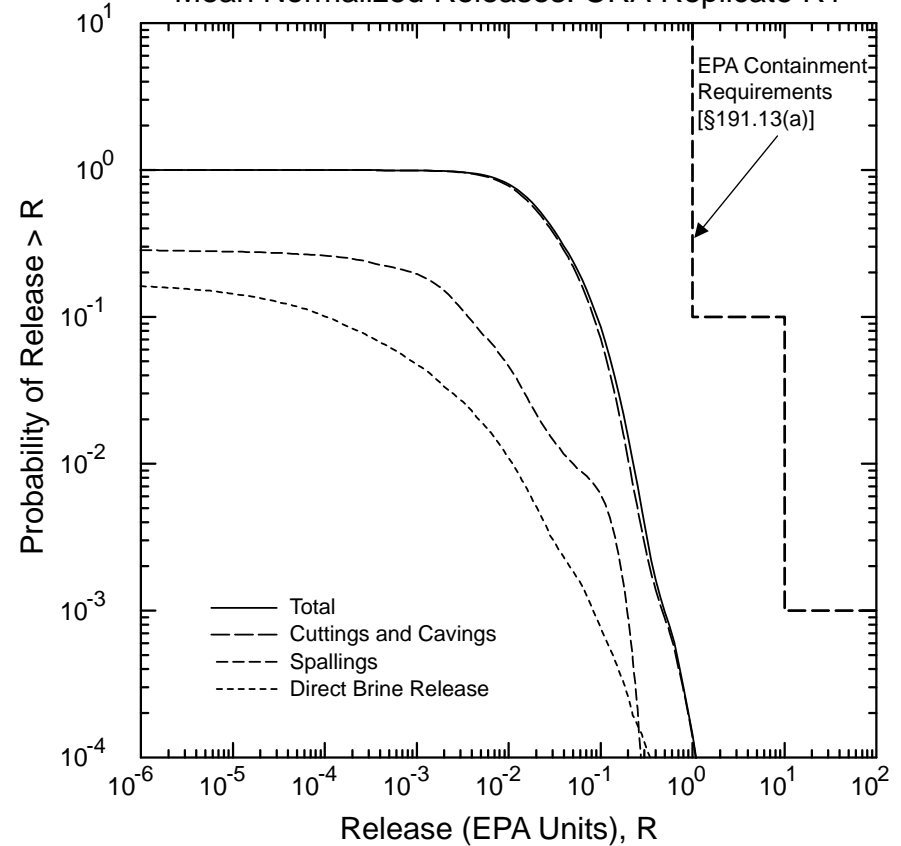 - **Compute release for each future**

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Comparison of Total Releases

Total Normalized Releases: CCA Replicate R1

Total Normalized Releases: CRA Replicate R1

Comparison of Total Releases (cont)

Comparison of Total Releases (cont)

Mean Total Normalized Release: Replicate R1

Mean Total Normalized Release: Replicate R1